Space Weather Technical Forecast

Issued on Sunday, 06 August 2023 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2 Minor/Moderate storm likely at times from CME arrivals. Further R1-R2 Radio blackouts likely. Further S1/Minor Radiation Storm impacts expected in the near term.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: High, with three M-flares and an X-flare in the last 24 hours. Peak flare was an X1.6, from AR3386 in the northwest. A long period M1.6 was also observed from this region. This is a compact region, primarily composed of two moderately sized spots, but with surrounding small spots leading to increased complexity. AR3387 also in the northwest has shown some growth, with the further emergence of a small mixed polarity delta spot to its southeast, and increased activity looks possible for this region. The other six numbered regions currently on the disc are all so far have been relatively stable, and either mature unipolar regions, or smaller bipolar regions. The largest of these is AR3394 in the southeast, however this is currently a simple unipolar spot set amongst a large area of plage. The recent X1.6 flare also from AR3386 at 05/2221 UTC has produced a significant CME, currently awaiting imagery and analysis, with updates to the forecast likely in future issues.

Solar Wind / Geomagnetic Activity: ACE/DSCOVR observed a CME arrive at L1 at 05/0209 UTC, likely the early arrival of a CME that was anticipated to arrive on 06 Aug. This showed a small increase in wind speeds from background levels of 380km/s to 450km/s, before easing again. Density increased from average levels to above average, peaking 30 ppcc. The total interplanetary magnetic field strength (Bt) was Moderate to Strong at 8-15nT, due to the previous CME arrival on 04 Aug, but then increased to be Strong at 15-25nT between 05/0220-0800 UTC in response to the new CME arrival, before easing to be weak around 7nT at the end of the period. The north-south component, (Bz) was initially southward (negative) with minimum value of -22nT at 05/0232 UTC, before easing, with brief positive (northward) orientated periods, but became generally weakly positive from 05/1000 UTC. Geomagnetic activity was Unsettled to Active to start, with G1-G2 Minor/Moderate Storm 05/0000-0900 UTC due the CME arrival, but declined to Quite from 05/1200 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux rose from background levels to peak at S1 Minor Radiation Storm from 05/1115 UTC, easing back towards the S1 threshold or just below by the end of the period. This was due to the M1.6 flare of AR3386 at 05/0719 UTC. GOES16 high energy (greater than 2MeV) electron flux was at background levels throughout. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu), with 1.20e6 integrated pfu recorded at 06/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Further M-flares are likely initially, mainly from AR3386 or AR3387, with a decreasing chance of M-flares from day 2 (7 Aug) onwards. Overall activity into the period High initially but expected to reduce to become Moderate to Low.

Solar Wind / Geomagnetic Activity: Waning CME influence is likely day 1. Next CME

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enhancement is likely to be day 2 or day 3 (7 or 8 Aug) from recent flare activity, although analysis continues on these complex eruptions. Overall geomagnetic activity is likely to be mainly Quiet initially, with isolated Unsettled spells day 1 (6 Aug). CME arrivals will likely increase this again to Active to G2 Moderate Storms for periods on day 2 or day 3 (7-8 Aug), declining in an uncertain manner into day 4 (9 Aug) pending further CME analysis.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is currently around the S1 Minor Storm Level, due to waning enhancement from the long period M1.6 flare from AR3386 on the northwest disc. These values were gradually declining in the near term. Further enhancement back above the S1 Minor Storm Level is expected day 1 (6 Aug) due to the recent X1.6 flare also from AR3386 however, and a slight chance of flux reaching towards S3 Strong Storm Levels. Any further elevated levels perhaps only easing into day 2 (7 Aug). The high energy electron flux (greater than 10 MeV) has the potential to briefly become enhanced later day 1-day 2 (6-7 Aug) as current CME influence recedes, however this will be suppressed by any further CME arrivals. The associated fluence likely remaining below the Active threshold (1e8 total pfu), but with a slight chance of rising above, mainly later day 1 or day 2.

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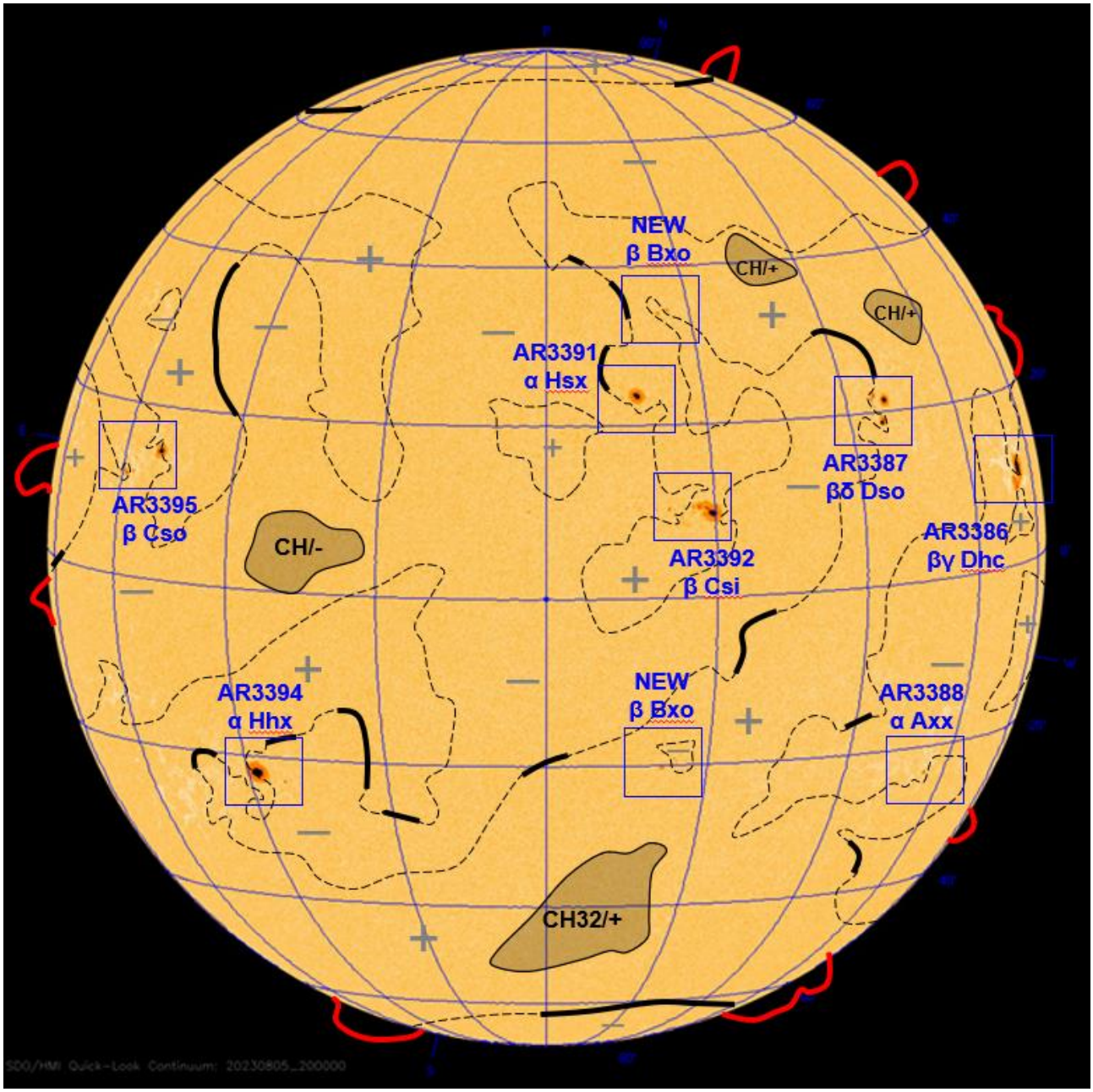
Figure 1. Solar Analysis Valid 05/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

CME arrival on 05 Aug has been attributed to an early arrival of the CME which left the Sun around 02/0900 UTC due to a filament eruption near centre-disc. Ongoing enhancement from this CME remains possible day 1 (6 Aug), but looks increasingly unlikely with a general trend of easing towards Quiet to Unsettled conditions expected as solar winds likely ease towards background. There remains some uncertainty with this current attribution of the CME however, and some further enhancement is possible early day 1 should another arrival occur.

Further CME arrival(s) are then possible later in the period. The first was due to a complex eruption from the northwest disc which occurred 04/0430 UTC due to the M2.0 flare of AR3386, rapidly followed at 05/0530 UTC by a filament lift just to the southeast of AR3386. This is now being revaluated as two separate CMEs, and a further enhancement is possible later day 2 or into day 3 (7-8 Aug). This will bring a further chance of Active to G1 Minor Storm intervals, and a chance of G2 Moderate Storms and a slight chance of G3 Strong Storms. A further CME has also been observed associated with the long period M1.6 flare from AR3386 at 05/0719 UTC, with analysis suggesting an almost concurrent glancing arrival with the previously mentioned CMEs. There is some potential for these to combine into the single more notable arrival. The recent X1.6 flare also from AR3386 at 05/2221 UTC has produced a significant CME, currently awaiting imagery and analysis, with updates to the forecast likely in future issues.

Faint positive coronal holes currently on the western disc are not expected to bring anything more than slight enhancements to the otherwise CME dominated or background solar wind. Overall geomagnetic activity is likely to be mainly Quiet initially, with isolated Unsettled spells day 1 (6 Aug). CME arrivals will likely increase this again to Active to G2 Moderate Storms for periods on day 2 or day 3 (7-8 Aug), declining in an uncertain manner into day 4 (9 Aug) pending further CME analysis.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	60	60	40
Strong	G3	No	1	10	10	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/0800	Partial	Flare	AR3386	920 km/s	07/12-2400 UTC	Glancing blow
04/1023	Partial	Filament	NE	595 km/s	07/12-2400 UTC	Glancing blow
05/1030	Partial	Flare/Filament	AR3386	1020 km/s	07/12-2400 UTC	Glancing blow

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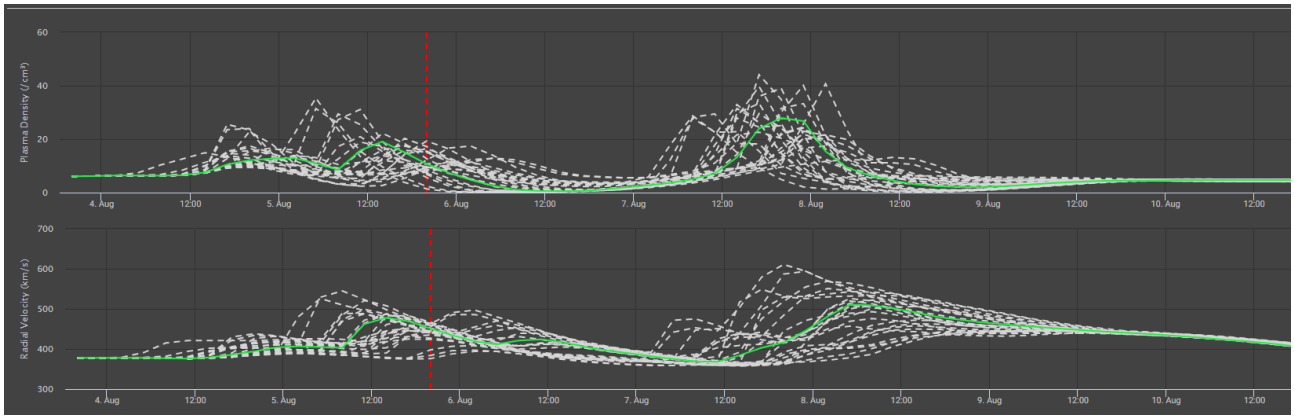
Figure 2: Latest MOSWOC ENLIL Ensemble output, showing broad and complex range of arrivals possible into the 7th Aug



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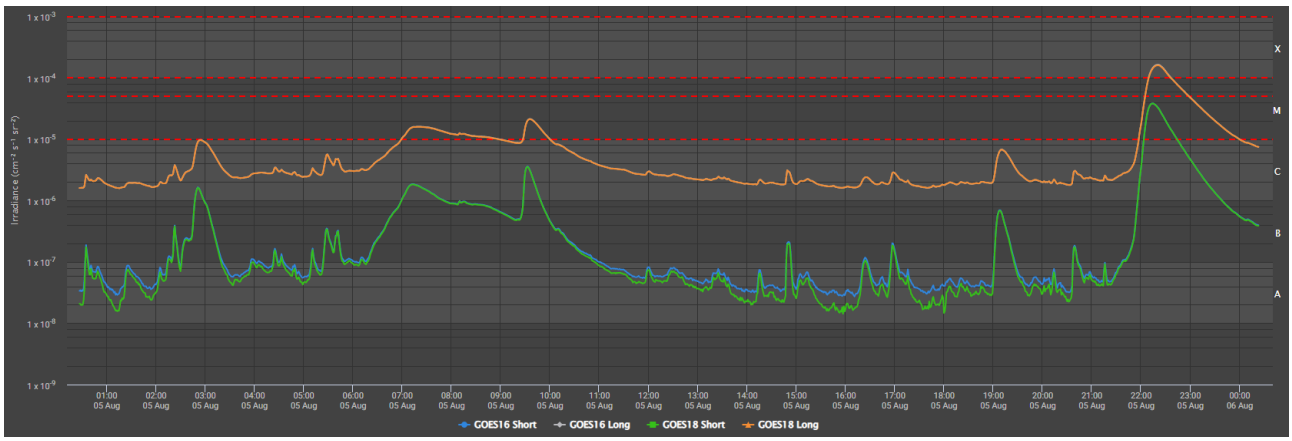
Radio Blackouts - X-Ray Flares:
Activity is currently High, with three M-flares and an X-flare in the last 24 hours. Peak flare was an X1.6, from AR3386 in the northwest. A long period M1.6 was also observed from this region. This is a compact region, primarily composed of two moderately sized spots, but with surrounding small spots leading to increased complexity. Motion is also evident between the two spots, and this spot has on ongoing potential for similar flares, before rotating off the visible disc through later day 1 into day 2 (6-7 Aug). AR3387 also in the northwest has show some growth, with the further emergence of a small mixed polarity delta spot to its southeast, and increased activity looks possible for this region. The other six numbered regions currently on the disc are all so far have been relatively stable, and either mature unipolar regions, or smaller bipolar regions. The largest of these is AR3394 in the southeast, however this is currently a simple unipolar spot set amongst a large area of plage. No signs of significant returning regions during the period.

Further M-flares are likely initially, mainly from AR3386 or AR3387, with a decreasing chance of M-flares from day 2 (7 Aug) onwards. Overall activity into the period High initially but expected to reduce to become Moderate to Low.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	60	40	30
Very Active	R3 to R5 X Class	Yes	10	5	5	5

Figure 3: Latest 24hr X-Ray trace, showing most recent X1.6 flare from AR3386



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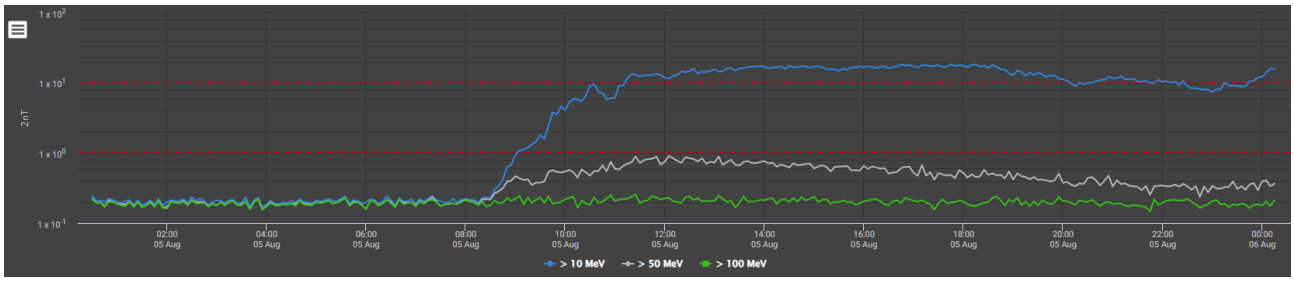
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10 MeV) proton flux is currently around the S1 Minor Storm Level, due to waning enhancement from the long period M1.6 flare of AR3386 on the northwest disc. These values were gradually declining in the near term. Further enhancement back above the S1 Minor Storm Level is expected day 1 (6 Aug) due to the recent X1.6 flare from AR3386 however, and a slight chance of flux reaching towards S3 Strong Storm Level. Any further elevated levels perhaps only easing into day 2 (7 Aug).

Risk decreases through day 3 (8 Aug), as the main active region currently will move further away from Earth on the far-side, with the proton flux expected to gradually ease towards background, and the other sunspot regions on the disc currently unlikely to produce significant proton enhancements.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	80	40	10	5
Very Active	**≥ S3 ***	No	10	5	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Latest 24hr GOES16 Proton Flux



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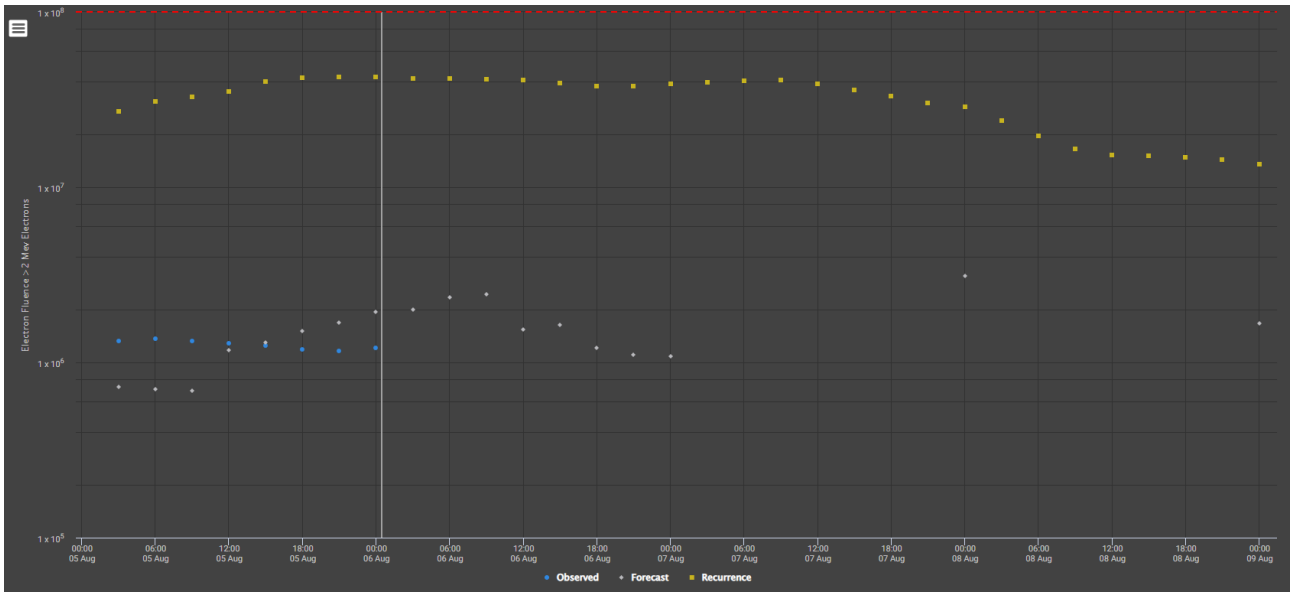
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 10 MeV) observed by GOES16 is currently at background, but likely became enhanced at lower orbits with the recent CME arrival. As any CME influence recedes day 1 into day 1 (6 Aug), flux is likely to see a rise. The extent and persistence of any such rise is very low confidence however, with the potential for further CME arrivals. These most likely on day 2 (7 Aug) with effect continuing into day 3 (8 Aug). Any such arrivals are likely to cause a drop out in observed flux, at least for the period of increased solar wind pressure, before flux potentially rises again as the CME influence recedes. A further complication to the forecast is the current slight proton enhancement, which has the potential to contaminate the observations.

Overall, the associated 24 hour fluence is likely to stay below the Active level, however there is a chance of this rising above, mainly late day 1 or early day 2 (6-7 Aug), before any subsequent CME arrival. REFM is likely to be unreliable in this period, due to the potential CME arrivals.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	20	30	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: Latest MOSWOC REFM model output



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